Specification as amended under Article 34(2)(b)

Amendment PCT

crown portion 82 in consideration of weight and heat conductivity is employed. However, this further increases the number of processing steps and boosts costs.

It is an object of the present invention which has been made in view of the above problems of the prior art to provide a process for manufacturing a tire vulcanizing mold having sufficiently high strength and durability efficiently, which is capable of forming a portion having a complex shape of the inner wall of a mold and an air vent or exhaust passage with high accuracy.

Summary of the invention

According to a first aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, comprising making the tire vulcanizing mold out of a plurality of mold elements which have fixed density in the thickness direction of the mold and differ from each other in density to provide a density distribution to the mold, and making at least part of a mold element for a tire tread portion out of a sintered member and a mold element for the mating portions of the mold out of a member having fewer pores than the sintered member or no pores. Thereby, the weight of the mold can be easily reduced while required strength is ensured.

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According to a second aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein part or all of the tire vulcanizing mold is manufactured by a powder sintering method in which sinterable powders are heated and sintered by local heating means such as a laser apparatus or microwave oscillator to form layers, wherein a low-density sintered body is used in a portion not requiring strength and having a complex structure of a tire crown portion, and a high-density sintered body is used in portions requiring strength such as a portion having few projections of the tire crown portion and the mating portions of the mold to provide the density distribution to the sintered body constituting part or all of the mold. Thereby, air bleeding can be carried out without using a vent hole and satisfactory strength as the mold can be ensured.

According to a third aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein the powders are heated and sintered by applying a laser beam and a density distribution is provided to the sintered body by controlling the output of the laser beam.

According to a fourth aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein the powders are heated and sintered by applying a laser beam,

and a density distribution is provided to the sintered body by controlling the exposure time of the laser beam.

According to a fifth aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein the porosity of the sintered body is changed by varying the size of the powders when the powders are heated and sintered.

According to a sixth aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein the powders are metal or alloy powders.

According to a seventh aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein the powders are aluminum powders.

According to an eighth aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein the tire vulcanizing mold is a piece type tire mold comprising a plurality of pieces for forming a tread pattern on a side in contact with the tread forming portion of a tire, some or all of the pieces are manufactured by the powder sintering method, and at least one of the pieces is composed of a plurality of mold elements which have fixed density in the thickness direction and differ from each other in density to provide a density

distribution to the piece.

According to a ninth aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein the plurality of pieces are integrally manufactured by the powder sintering method, and an air bleeder slit is formed at the boundary between adjacent pieces by weakening or omitting the application of a laser beam to the powders in a predetermined area between the pieces.

According to a tenth aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein the pieces are each manufactured by the powder sintering method, and an air bleeder slit is formed in piece dividing surfaces by weakening or omitting the application of a laser beam to at least some or all of powders in contact with the piece dividing surfaces of the piece.

According to an eleventh aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein a mold element arranged at a place where an air bank of a tire crown portion is readily formed, such as a place around the projection or an intersection between the projections is manufactured by the powder sintering method and the mold element composed of this sintered

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What is claimed is:

1. (Amended) A process for manufacturing a tire vulcanizing mold, comprising making the tire vulcanizing mold out of a plurality of mold elements which have fixed density in the thickness direction of the mold and differ from each other in density to provide a density distribution to the mold, and making at least part of a mold element for a tire tread portion out of a sintered member and a mold element for the mating portions of the mold out of a member having fewer pores than the sintered member or no pores.

2. (Amended) The process for manufacturing a tire vulcanizing mold according to claim 1, wherein part or all of the tire vulcanizing mold is manufactured by a powder sintering method in which sinterable powders are heated and sintered by local heating means to form layers and the density distribution is provided to the sintered body.

3. The process for manufacturing a tire vulcanizing mold according to claim 2, wherein the powders are heated and sintered by applying a laser beam and a density distribution is provided to the sintered body by controlling the output of the laser beam.

4. The process for manufacturing a tire vulcanizing

mold according to claim 2, wherein the powders are heated and sintered by applying a laser beam, and a density distribution is provided to the sintered body by controlling the exposure time of the laser beam.

5. The process for manufacturing a tire vulcanizing mold according to any one of claims 2 to 4, wherein the porosity of the sintered body is changed by varying the size of the powders when the powders are heated and sintered.

6. The process for manufacturing a tire vulcanizing mold according to any one of claims 2 to 5, wherein the powders are metal or alloy powders.

7. The process for manufacturing a tire vulcanizing mold according to claim 6, wherein the powders are aluminum powders.

8. (Amended) The process for manufacturing a tire vulcanizing mold according to any one of claims 2 to 7, wherein the tire vulcanizing mold is a piece type tire mold comprising a plurality of pieces for forming a tread pattern on a side in contact with the tread forming portion of a tire, some or all of the pieces are manufactured by the powder sintering method, and at least one of the pieces is composed of a plurality

of mold elements which have fixed density in the thickness direction and differ from each other in density to provide a density distribution to the piece.

9. The process for manufacturing a tire vulcanizing mold according to claim 8, wherein the plurality of pieces are integrally manufactured by the powder sintering method, and an air bleeder slit is formed at the boundary between adjacent pieces by weakening or omitting the application of a laser beam to the powders in a predetermined area between the pieces.

10. The process for manufacturing a tire vulcanizing mold according to claim 8, wherein the pieces are each manufactured by the powder sintering method, and an air bleeder slit is formed in piece dividing surfaces by weakening or omitting the application of a laser beam to at least some or all of powders in contact with the piece dividing surfaces of the piece.

11. The process for manufacturing a tire vulcanizing mold according to claim 1, wherein a mold element arranged around the projection of at least a tire crown portion is manufactured by the powder sintering method and the mold element composed of this sintered body is assembled with a separately manufactured mold body or piece.

12. The process for manufacturing a tire vulcanizing mold according to claim 11, wherein the mold element is set in a mold for casting the mold body or the piece and assembled with the mold body or piece at the time of casting.

13. The process for manufacturing a tire vulcanizing mold according to claim 11, wherein the mold element is buried in the separately cast mold body or piece.

14. The process for manufacturing a tire vulcanizing mold according to any one of claims 1 to 13, wherein to manufacture at least part or all of the mold or at least some or all of the pieces by the powder sintering method in which sinterable powders are heated and sintered to form layers, a tire 3-D CAD is used to create a model of the tire, lamination models are created by dividing this model with parallel planes having a predetermined angle, and the powders are heated and sintered for each layer based on the lamination models.

15. The process for manufacturing a tire vulcanizing mold according to claim 14, wherein the lamination pitch is 0.1 to 0.5 mm.

16. (Amended) A tire vulcanizing mold comprising a

plurality of mold elements which have fixed density in the thickness direction of the mold and differ from each other in density, wherein a mold element for a tire tread portion is a composed of a sintered body and a mold element for the mating portions of the mold is composed of a member having few pores or no pores.

17. The tire vulcanizing mold according to claim 16, wherein part or all of the tire vulcanizing mold is manufactured by heating and sintering sinterable powders with local heating means to laminate layers.

18. The tire vulcanizing mold according to claim 17, wherein a mold element arranged around the projection of at least a tire crown portion is manufactured by the powder sintering method.

19. (Amended) The tire vulcanizing mold according to any one of claims 16 to 18, wherein the tire vulcanizing mold is a piece type tire mold comprising a plurality of pieces for forming a tread pattern on a side in contact with the tire tread forming portion of a tire, and at least one of the pieces is composed of a plurality of mold elements which have fixed density in the thickness direction and differ from each other in density.

lamination pitch is 0.1 to 0.5 mm.

According to a sixteenth aspect of the present invention, there is provided a tire vulcanizing mold comprising a plurality of mold elements which have fixed density in the thickness direction of the mold and differ from each other in density, wherein a mold element for a tire tread portion is a composed of a sintered body and a mold element for the mating portions of the mold is composed of a member having few pores or no pores such as a member having higher density, therefore, lower porosity than the sintered body,.

According to a seventeenth aspect of the present invention, there is provided a tire vulcanizing mold, wherein part or all of the tire vulcanizing mold is manufactured by heating and sintering sinterable powders with local heating means to laminate layers.

According to an eighteenth aspect of the present invention, there is provided a tire vulcanizing mold, wherein a mold element arranged around the projection of at least a tire crown portion is manufactured by the powder sintering method.

According to a nineteenth aspect of the present invention, there is provided a tire vulcanizing mold, wherein the tire vulcanizing mold is a piece type tire mold comprising a plurality of pieces for forming a tread pattern on a side in contact with the tire tread forming portion of a tire, and at least one of the pieces

is composed of a plurality of mold elements which have fixed density in the thickness direction and differ from each other in density.

According to a twentieth aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, comprising the steps of:

manufacturing at least part or all of a mold by a powder sintering method in which sinterable powders are heated and sintered to laminate layers, and

infiltrating a metal or alloy into the pores of the laminated sintered body of the mold.

According to a twenty-first aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein the density of the mold is controlled by adjusting the infiltration of the metal or alloy.

According to a twenty-second aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein the powders are metal or alloy powders.

According to a twenty-third aspect of the present invention, there is provided a process for manufacturing a tire vulcanizing mold, wherein the powders are aluminum powders.

According to a twenty-fourth aspect of the present invention, there is provided a process for